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Abstract

Although first introduced into cultivation in the 1870's and praised for its ornamental character, *Alnus maritima* (Marsh.) Muhl. ex Nutt. (seaside alder) remains a rare woody species with unrealised potential. The ornamental promise of *A. maritima* was first recognised by Thomas Meehan, an Englishman who emigrated to the United States (Philadelphia, Pa). In 1848 after serving for two years at the Royal Botanic Gardens, Kew, Mr. Meehan was best known as the publisher of *Meehan's Monthly* (1891- 1902) and as the author of *The American Handbook of Ornamental Trees* (1853) and *The Native Flowers and Ferns of the United States* (1878-1880). In 1878, Mr. Meehan donated specimens of *A. maritima* to the Arnold Arboretum in Massachusetts.

Disciplines

Agricultural Science | Botany | Horticulture | Plant Biology | Plant Pathology

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Alnus maritima: a rare woody species from the New World

JAMES A. SCHRADER
& WILLIAM R. GRAVES

Although first introduced into cultivation in the 1870's and praised for its ornamental character, *Alnus maritima* (Marsh.) Muhl. ex Nutt. (sea-side alder) remains a rare woody species with unrealised potential. The ornamental promise of *A. maritima* was first recognised by Thomas Meehan, an Englishman who emigrated to the United States (Philadelphia, Pa). In 1848 after serving for two years at the Royal Botanic Gardens, Kew, Mr. Meehan was best known as the publisher of *Meehan's Monthly* (1891–1902) and as the author of *The American Handbook of Ornamental Trees* (1853) and *The Native Flowers and Ferns of the United States* (1878–1880). In 1878, Mr. Meehan donated specimens of *A. maritima* to the Arnold Arboretum in Massachusetts. The

appearance of plants, which had flourished at the arboretum, led C. S. Sargent (1896) to write "Its brilliant foliage and its bright golden staminate filaments, hanging in September from the ends of the slender leafy branches, make it at that season of the year an attractive ornament for parks and gardens." Since that time, few people have become aware of this handsome alder. In 1986, Peter Mazzeo, botanist at the U.S. National Arboretum, wrote that *A. maritima* was not commonly cultivated but was sometimes grown as a rare species or a botanical curiosity (Mazzeo, 1986). Today, commercial production of this species is scant, but its ornamental appeal and physiological attributes have renewed interest in the development of *A. maritima* for use in managed landscapes.

CLASSIFICATION AND DISTRIBUTION

Of the nine species of *Alnus* (Betulaceae) native to North and South America, *Alnus maritima* is the only member of subgenus *Clethropsis* (Spach) Regel; all others have been placed in the subgenera *Alnus* or *Alnobetula* (Ehrhart) Petermann (Furrow, 1979). The two other members of subgenus *Clethropsis*, *Alnus nepalensis* D. Don and *Alnus nitida* (Spach) Endl., are indigenous only to southern Asia. Subgenus *Clethropsis* is distinguished from other alders by its autumnal flowering habit. All other alders flower in spring. Autumn flowering prevents *A. maritima* from hybridising naturally with other alder species and aids the identification of plants in the wild. *Alnus maritima* and *Alnus serrulata* (Ait.) Willd. are sympatric in Georgia and on the Delmarva Peninsula, but the two species remain segregated by temporal isolation.

Murai (1964) was the first author to place *A. maritima* among its natural relatives in subgenus

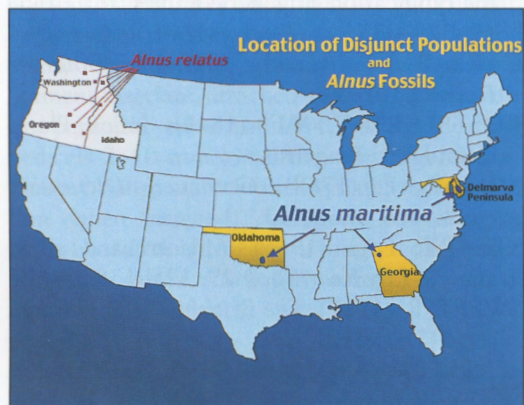


PHOTO: JAMES SCHRADER

Distribution of *Alnus maritima*, found naturally in only three small disjunct populations in Oklahoma, Georgia, and on the Delmarva Peninsula (Delaware and the Eastern Shore of Maryland). Also shown are sites in the northwestern United States where fossils of *Alnus relatus* have been found



PHOTO: WILLIAM GRAVES

Alnus maritima growing with roots completely submerged in water (Oklahoma)

Clethropsis, but Murai considered *Clethropsis* to be merely a section and placed it, along with four other sections, in subgenus *Gymnothyrsus*. Stibolt (1978) acknowledged Murai's arrangement of the genus, but after comparing leaf characteristics, concluded that *Clethropsis* and section *Japonicae*, were very similar and, taken together, were distinct from other alders. Furlow (1979) undertook a thorough examination of American *Alnus* including numerical taxonomic and chemosystematic studies and finally promoted *Clethropsis* to the rank of subgenus with the three autumn-blooming species as its only members. Furlow (1979) provided a solid assessment of *A. maritima* and its relationship with alders of the New World, but substantial similarities between subgenera *Clethropsis* and *Japonicae* suggest that work on the infrageneric systematics of all *Alnus* species is not yet complete.

Alnus maritima was first described by Humphry Marshall (1785), who gave it the binomial name *Betula-Alnus maritima* and the persisting common name, seaside alder. Nuttall

(1842) later described *A. maritima* as a species in the genus *Alnus*, published the name *Alnus maritima*, and cited an unpublished manuscript by Muhlenberg (1807) as the origin of the name. In 1947, Sargent included both Marshall and Nuttall as authors of previous descriptions of this species, with no mention of the work of Muhlenberg. Likewise, Murai (1964) recorded the name and its authorities as *Alnus maritima* (Marsh.) Nuttall. Furlow (1976), believing that the species must be renamed because Nuttall based his name on Muhlenberg's manuscript, rather than on the first available epithet (*maritima*, from *Betula-Alnus maritima* Marshall), offered the name *Alnus metoporina* Furlow. Stibolt et al. (1977), citing Article 55 (2) of the *International Code of Botanical Nomenclature* (Stafleu et al., 1972), demonstrated that the name change was unnecessary, and the previous name, *Alnus maritima* (Marsh) Muhl. ex Nutt., must be retained. Stibolt (1978) also revealed the erroneous use of the name *A. maritima* by some authors when referring to certain

Asian alders. Examples of this incorrect usage include *A. maritima* β *japonica* Regel, *A. maritima* var. *obtusata* Fr. et Sav., and *A. maritima* var. *formosana* Burk (Stibolt, 1978). There has been one attempt to classify *A. maritima* at the infraspecific level. In 1983, Murray proposed that the two populations known at the time be considered subspecies and/or varieties, apparently based solely on their geographic disjunction. The population in Delaware and Maryland he named *Alnus maritima* subsp. *maritima*, and he proposed the population in Oklahoma be called *Alnus maritima* subsp. *metoporina* (Furlow) E. Murr. (Murray, 1983). Our present research concerning the ecology and biosystematics of *A. maritima* should help determine if Murray's assessment was correct.

Alnus maritima occurs naturally in only three small, disjunct populations in the United States. It is indigenous to the Delmarva Peninsula (Eastern Shore of Maryland and southern Delaware), south-central Oklahoma, and north-western Georgia, where it was discovered in 1997 growing in and around a small swamp (Brian Dickman, pers. comm.). The origin of the disjunct and limited distribution of *A. maritima* has been the topic of much speculation. Before discovery of the population in Georgia, some believed the population in Oklahoma was transplanted from the Delmarva Peninsula by Native Americans (Duke, 1983; Stibolt, 1981). Motivation for such an endeavour might have been the demand for *Alnus* tissue in folk medicine; *Alnus* remedies were used to treat many human ailments (Duke, 1983). Others believe the present distribution of *A. maritima* to be the remnant of a much larger range (Furlow, 1979; Stibolt, 1978). Evidence supporting this theory includes the distant location of its closest allies (southern Asia) and the fossil remains of an extinct species much like *A. maritima* (*Alnus relatus* [Knowlton] Brown) that has been found in the north-western United States (Brown, 1937; Chaney, 1959; Chaney & Axelrod, 1959; Graham, 1965). This evidence also suggests the possibility that ancestors of subgenus *Clethropsis* from the New World and Old World may have had a continuous distribution

across the Bering land bridge (Furlow, 1979). The discovery of *A. maritima* in Georgia would seem to support the second theory, but the limited size of this population, which is found on approximately 50 hectares, allows for the belief that it too was introduced.

Regardless of the origin of its present distribution, its rarity has led to the placement of *A. maritima* on the threatened species lists of the Georgia, Oklahoma, and Maryland Natural Heritage Inventories where it has been classified as critically imperilled, imperilled, and a watch-list species, respectively (Georgia Natural Heritage Program, 1999; Maryland Heritage & Biodiversity Conservation Program, 1994; Oklahoma Natural Heritage Inventory, 1997). *Alnus maritima* also appeared as a "Threatened" species on the original, congressional "Report on Endangered and Threatened Plant Species of the United States" (Ripley, 1975). More recently, *A. maritima* has been removed from the federal endangered species list and given a federal status of 3C, which means it is among those "taxa that have proven to be more abundant or widespread than previously believed and/or those that are not subject to any identifiable threat" (Maryland Heritage & Biodiversity Conservation Program, 1994). The World Conservation Monitoring Centre lists the status of *A. maritima* as rare for Delaware and Maryland, vulnerable for Oklahoma, and rare for the World (Walter & Gillett, 1998).

HORTICULTURAL POTENTIAL

Alnus maritima is a large shrub or small tree that grows to a height of 10 m with several trunks up to 15 cm in diameter. It has glossy, tatter-resistant foliage that is the darkest green of the American alders (Furlow, 1979), and we have observed trees in the wild with reddish-brown leaf colour in late autumn. The red pistillate flowers of *A. maritima* are borne in scaly clusters (strobili) close to branch ends, while its yellow staminate flowers are borne in terminal, pendulous catkins. The bright yellow catkins are particularly ornamental against the dark green foliage, and early-autumn flowering provides a

unique attractiveness at a time of year when few other woody species are in bloom. "As a garden-plant this Alder has considerable beauty, especially in the autumn when it is covered with its large, bright, golden-coloured catkins of male flowers which hang from the ends of the slender branches" (Sargent, 1891).

Representatives of this species can be found in several gardens and arboreta both in the United States and in the United Kingdom. In the United States, *A. maritima* can be seen at Arnold Arboretum, Holden Arboretum (Kirtland, Ohio), Morton Arboretum (Lisle, Illinois), and at Reiman Gardens on the campus of Iowa State University (Ames, Iowa). In the United Kingdom plants can be seen at Younger Botanical Garden, Sir Harold Hillier Gardens and Arboretum, and at the Royal Botanic Gardens Kew. At Kew there are two trees in the alder collection by the lake. The older of the two was planted in the spring of 1979 and had reached a height of 5 metres by 1997. The second tree was planted in 1988. Both of the trees are growing well in the climate of south-eastern England.

Although they are members of the same species, plants from the three separate populations of *A. maritima* have been shown to possess morphological differences, even when grown under the same environmental conditions (Schrader & Graves, 2000a). When grown together in a greenhouse, leaves of plants from the Oklahoma population were longer and narrower than the leaves of plants from Georgia and the Delmarva Peninsula. Plants from Oklahoma were more densely foliated than plants from Georgia and had a more upright growth habit than plants from Georgia and the Delmarva Peninsula. These and other differences in plants from the three locations illustrate genetic divergence among the three disjunct populations and the potential for selection of *A. maritima* with superior horticultural traits (Schrader & Graves, 2000a).

Alnus maritima and other alders are actinorhizal species that can utilise atmospheric nitrogen through a symbiotic relationship with the nitrogen-fixing actinomycete, *Frankia*. Benson and Silvester (1993) conclude that acti-

norhizal plants could be particularly useful in reclaiming and conditioning soil, and acting as nurse, windbreak, and ornamental plants. Alders have been used extensively in Europe and Japan as ornamentals and hedges along rivers and streams to control erosion (Hashimoto et al., 1973; Wheeler & Miller, 1990). In the United States, alders are planted as ornamentals, but they are also used extensively for reclamation of areas strip-mined for coal (Lowry et al., 1962). Alders are preferred for reclamation projects because they establish quickly, grow rapidly, produce abundant leaf litter, and fix nitrogen (Funk, 1973). The capacity to utilise atmospheric nitrogen should make *A. maritima* an excellent choice for landscapes where low soil nitrogen limits growth of other species or where there is a desire to minimise fertiliser use.

In the wild, *A. maritima* is restricted to soils that are at least periodically saturated with fresh water, and when it occurs with other woody, lowland species, it appears to have a selective advantage in the wettest soils. Its natural preference for saturated soils should make *A. maritima* especially useful in landscapes prone to flooding and may make it superior to other alders in erosion-control applications. Hennessey et al. (1985) have shown that *A. maritima* can perform better under moderate and severe drought stress than does *Alnus glutinosa* (L.) Gaertn. While *A. glutinosa* developed thin, chlorotic leaves and reduced apical dominance in response to water-deficit stress, these morphological changes were not observed in *A. maritima* under the same treatment conditions. This evidence suggests that, although it occurs naturally only in wet soils, *A. maritima* may also be useful on well-drained sites. Field trials with one-year-old seedlings installed on well-drained sites in Iowa support this conclusion. In their second season and receiving only natural precipitation, plants appeared healthy and showed abundant growth. Along with these field trials, researchers at Iowa State University are performing experiments that will quantify the responses of *A. maritima* to water stress.

Preliminary results from a study we have



PHOTO: WILLIAM GRAVES

Glossy, dark-green foliage and immature catkins of *Alnus maritima* from Oklahoma

begun on cold hardiness indicate that, although the three populations of *A. maritima* are found in United States Department of Agriculture (USDA) hardiness zone 7 (mean annual minimum temperature of -12 to -18°C), plants may be hardy in areas with mid-winter temperatures below -30°C . Over 300 seedlings from seed sources in Oklahoma, planted on sites in Iowa located in USDA hardiness zones 4b and 5a (mean annual minimum temperatures of -29 to -32°C and -26 to -29°C , respectively), showed 100% survival through the winter of 1998-99, which included a one-time low temperature of -35°C on January 5. Plants showed survival of the entire shoot, including the apex. Another small trial with 30 seedlings planted in northern Minnesota (USDA Zone 3a, mean annual minimum temperature of -37 to -4°C) resulted in 93% survival through the first winter. Results from a more thorough assessment of tissue hardiness, which includes seedlings from all three populations of *A. maritima*, should be completed in 2001.

The potential for invasiveness, which is a problem with some introduced species, may not be a concern with *A. maritima* when plants are utilised in areas with mean annual minimum temperatures equal to or colder than those of their native range (-15°C and lower). Even though plants are hardy in areas with colder temperatures than those of their natural provenances, cold hardiness of *A. maritima* seeds may be much more limited. The timing of *A.*



PHOTO: WILLIAM GRAVES

Strobili of *Alnus maritima* matured during the present season (bottom) and matured during the previous season's growth (top)

maritima seed dispersal (between November and March) exposes seeds to winter temperatures that reduce seed survival and germinability. Schrader and Graves (2000b) have shown that germination of seeds from Oklahoma is reduced from 63.3% to 19.5% after three- and six-day exposures of stratified seeds to temperatures typical of native habitats in winter (-15°C). Exposures of stratified seeds to temperatures colder than those of native habitats (-20°C) kills all but 0.7% of the seeds from all three populations. *Alnus maritima* shows strong potential for use in managed landscapes with little threat of becoming a nuisance.

PROPAGATION AND PRODUCTION

Alnus maritima is easily propagated from both seed and softwood cuttings. Strobili, the cone-like fruits of *A. maritima*, mature in late autumn. In November and early December seeds are completely mature and strobili are relatively dry, but no seed dispersal has taken place. Seeds can be found in strobili later, but most of the seeds are dispersed during the winter months. Only about a third of the seeds remains in the strobili by the middle of March, and germinability is lower for seeds that persist

on trees through the winter (Schrader & Graves, 2000b). One potential problem with seed collection is the presence of strobili from a previous season. These older strobili are retained on the plant but contain no viable seeds. Care must be taken to select only strobili that have matured during the present season.

Stratification increases the rate, completeness, and uniformity of germination for seeds of *A. maritima* (Schrader & Graves, 2000a). Six to 10 weeks of cold stratification should be used to optimise germination. Seeds should be placed between pieces of moist paper in a sealed plastic container (to prevent evaporation) and be held at approximately 4°C. Seeds from trees of the Oklahoma population show a higher average germination percentage (55%) than do seeds from Georgia (31%) or the Delmarva Peninsula (15%), and germination varies between seed sources (maternal plants) within each population. Germination ranged from 38 to 82% for seed from trees in Oklahoma, from 12 to 58% for seed from trees in Georgia, and from 4 to 29% for seed from trees on the Delmarva Peninsula when mean averages were calculated by tree of origin (Schrader & Graves, 2000a). Successful seed propagation will depend on the selection of good source trees, as well as application of the proper stratification treatment.

Softwood cuttings can be an effective way to propagate *A. maritima* (Schrader & Graves, 2000c). Terminal cuttings collected in June from mature plants in the wild have been shown to root well, especially when pre-treated with rooting compound containing indole-3-butyric acid (IBA) at 8g/kg. By using this IBA concentration, cuttings from seven trees in Oklahoma showed an average of 68% rooting, with cuttings from one of these trees rooting at 95%. Cuttings collected from trees in Oklahoma showed a higher percentage of rooting (68%) than did cuttings from trees of the Delmarva Peninsula (29%) and should be more useful for vegetative propagation (Schrader & Graves, 2000c). These results were obtained for cuttings stuck in wooden flats filled with perlite and held under intermittent mist for 9 weeks.

Cuttings should be collected early in the season (mid-June) when using mature plants as ortets.

Vegetative propagation can be optimised by using cuttings from juvenile stock plants. In June, 1999, we conducted a trial by using terminal and non-terminal softwood cuttings from one-year-old seedlings of *A. maritima* that were grown under greenhouse conditions. Cuttings taken from seedlings representing all three populations were pre-treated with rooting compound (IBA at 8g/kg) and held under intermittent mist for 6 weeks. Non-terminal cuttings (two- and three-node) from the three populations survived and rooted better (88%) than did terminal cuttings (54%). Mean averages combined over cutting types showed that cuttings from seedlings from Oklahoma had the greatest rooting success (81%) compared to cuttings from seedlings from Georgia (72%) and Delmarva (59%). Terminal and non-terminal cuttings from two of the seedlings from Oklahoma and one of the seedlings from Georgia showed 100% rooting. Along with the higher survival and rooting of cuttings taken from juvenile plants, clones produced from juvenile tissue show more vigorous shoot growth than clones propagated from mature ortets. Propagation and production of *A. maritima* from softwood cuttings will be most successful when using juvenile plants as ortets, and the use of stock seedlings, rather than mature plants in the wild, will spare the natural populations from the physical disturbance of cutting collection.

Seedlings and plants produced from softwood cuttings show excellent growth and have the potential to reach marketable size very quickly. With seedlings, there is an initial period of slow development that lasts up to 3 or 4 weeks after germination. After this period, seedlings grow very quickly and can reach a height of 60 cm with 14 weeks of additional growth. Under greenhouse conditions, *A. maritima* can grow from seed to 2 metres in height within 18 months. Only slightly less vigorous, rooted cuttings from juvenile stock produce attractive plants within the same time frame. Along with the benefits of nitrogen fixation that

are observed with plants in the landscape, this biological process also may lower production costs by reducing the need for fertiliser. Our plants that reached a height of 2 metres within 18 months received fertiliser of 11.0 mM N (16.5N-2.2P-13.5K) in tap water once a week during the first six months of growth and then were given no fertiliser for the next year. These plants showed vigorous growth with no observable signs of nitrogen deficiency.

Based on limited observations and reports, it appears that spring is the best time for installation of plants in the landscape. Seedlings planted out in autumn after growing under greenhouse conditions are densely foliated and struggle with limited water availability unless irrigated generously. Autumn planting in areas colder than native habitats also appears to limit the ability of seedlings to acclimatise before winter. Under the conditions in Iowa, more winter damage has been seen on seedlings planted in autumn than on seedlings planted during spring or summer. Seedlings establish well when overwintered in cold storage for three months and planted out in spring. Spring planting of seedlings that are just beginning to form leaves reduces the need for irrigation, permits root growth before the stress of summer heat and irradiance, and allows plants the entire season to adjust to climatic conditions before winter.

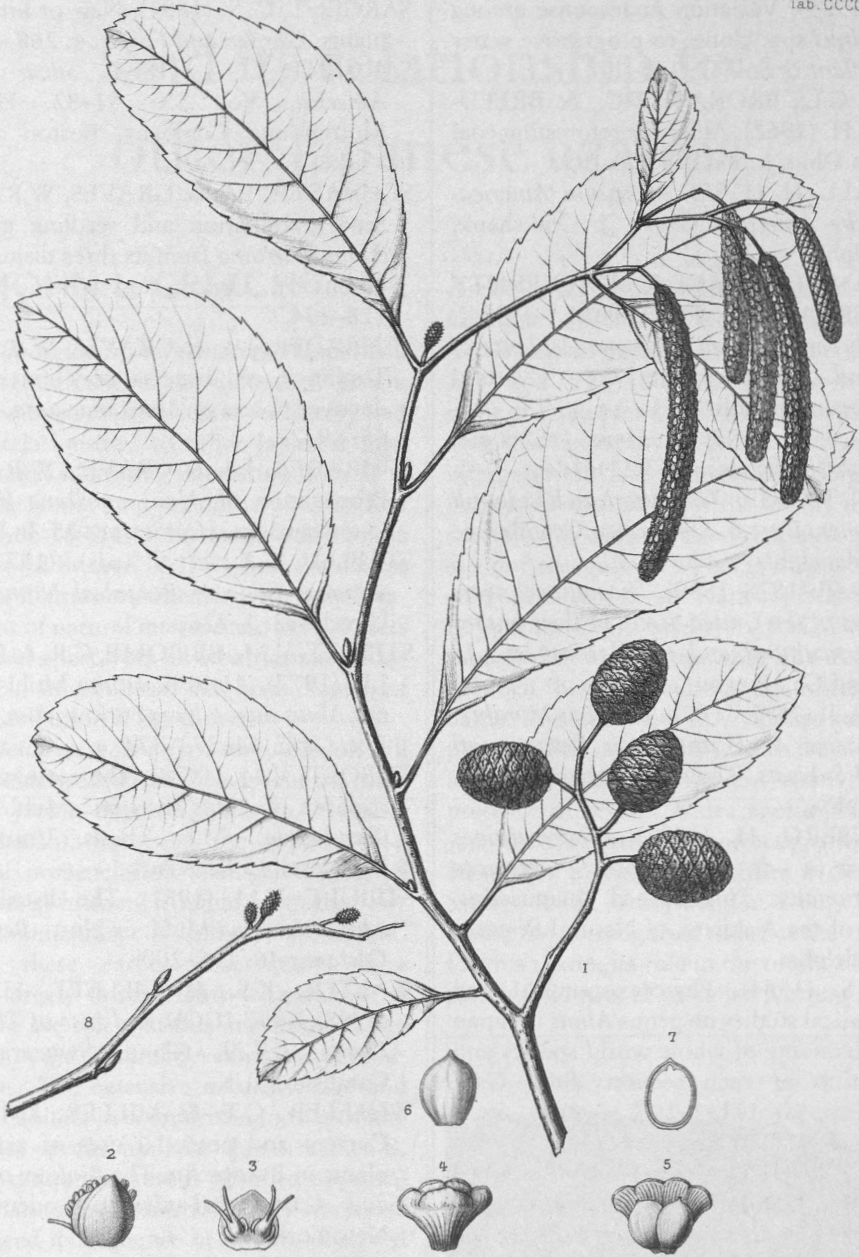
Although escaping the attention of horticulturists for over 100 years after its first cultivation, *A. maritima* is once again being recognised for its strong potential as a stress-resistant large shrub or small tree for use in managed landscapes. Its striking ornamental features, promising physiological attributes, and ease of propagation, along with its peculiar timing of anthesis, intriguing disjunct distribution, and status as a rare and threatened species, make *A. maritima* a very interesting woody taxon deserving of further study, greater recognition, and increased use in the landscape.

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Tab. CCCCLVIII.



C. E. Faxon del.

ALNUS MARITIMA, Nutt.

Rapine sc.

A. Riccio dirac^o

Imp. J. Tanour, Paris.

Alnus maritima from C.S. Sargent, *Silva of North America* Vol IX:82 (1896).

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